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Dated 22 August 2003

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THE PATENT OFFICE
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23 AUG 2002
LONDON

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
South Wales
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1. Your reference — M02B148/RJB

2. Patent application number *(The Patent Office will fill in this part)* — 0219739.0 — 23 AUG 2002

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

The BOC Group plc, Chertsey Road, Windlesham, Surrey, GU20 6HJ

Patents ADP number *(if you know it)* — 884627002

If the applicant is a corporate body, give the country/state of its incorporation — England

4. Title of the invention

Improved Methods for the Manufacture of Ice Cream

5. Name of your agent *(if you have one)* — Roger James Bousfield

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

The BOC Group plc, Chertsey Road, Windlesham, Surrey, GU20 6HJ

Patents ADP number *(if you know it)* — 973131002

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

Yes

9. Enter the number of sheets for any of the following items you are filing with this form.
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Continuation sheets of this form	0
Description	4
Claim(s)	1
Abstract	0
Drawing(s)	0

10. If you are also filing any of the following, state how many against each item.

Priority documents	0
Translations of priority documents	0
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	0
Request for preliminary examination and search *(Patents Form 9/77)*	1
Request for substantive examination *(Patents Form 10/77)*	0
Any other documents *(please specify)*	0

11. I/We request the grant of a patent on the basis of this application.

Signature: R M Bousfield Date: 22 August 2002

12. Name and daytime telephone number of person to contact in the United Kingdom

Roger Bousfield
(01276) 807612

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Notes

a) If you need help to fill in this form or you have any questions, please contact the Patent Office on 08459 500505.

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IMPROVED METHODS FOR THE MANUFACTURE OF ICE CREAM

This invention relates to the manufacture of ice cream and, more particularly to the use of cryogenically produced fat in the manufacture of ice cream.

Ice cream is made commercially from an oil-in-water emulsion. The disperse phase contains a mixture of oil and solid fat (usually at least 80% solid or crystalline fat at -5°C) as well as an emulsifier (usually a mixture of lipophilic mono- and di-glycerides), whilst the aqueous phase contains a number of ingredients, of which milk protein, sugar and a stabiliser are the most important components in common use. Alternatively, a monoglyceride emulsifier may be dissolved in the aqueous phase with the other water-soluble ingredients.

In general, the manufacture of ice cream involves the following basic steps. After blending the liquid and dry ingredients using a high-speed mixer, the ice cream mix or emulsion is pasteurised, homogenised and cooled, by which time the oil/fat phase is stabilised by a layer of adsorbed milk proteins. It is then held in "conditioning" or "ageing" tanks at about 5°C for many hours prior to freezing in order to allow the milk protein to be displaced from the surface of the fat globules by the emulsifier and to permit the solid fat, especially the higher melting point fat, to crystallise. This conditioning stage is vitally important because it is only when a) the emulsifier has displaced the interfacial protein and itself comes to occupy the oil-water interface of each fat droplet and b) fat crystallisation has occurred, that it is possible for fat globules to stabilise air bubbles by attaching to their surface during air incorporation, and thus form a stable, high volume foam for freezing. The time required for this "conditioning" or "ageing" stage of production is long (and therefore expensive) and inevitably increases the cost of the final product, but also dictates that the manufacture of ice cream is intrinsically a discontinuous process. This step is followed by air incorporation and dynamic freezing in a scraped surface heat exchanger and, finally, hardening by blast freezing at –30°C to –40°C.

In the method of the invention, it has been found that the two most important changes to fat globules during "conditioning" or "ageing" of conventional processing, namely, crystallisation of the fat phase and emulsifier associated with their surface, can be readily achieved by cryogenically freezing a fine aerosol or spray or mist of a suitable fat (milk fat, anhydrous milk fat, milk fat fractions, hydrogenated vegetable oil, non-hydrogenated hard vegetable fat or any other edible oil containing a suitable level of solid fat) containing an emulsifier to produce a fine fat powder, although other cooling processes that achieve these conditions may also be used for the same purpose. Such is the flexibility of the method of the invention that it has also been found possible to crystallise the fat phase without an added emulsifier and instead to associate an emulsifier with the surface of the fat particles by including the surfactant into the aqueous phase. In this case, the emulsifier becomes associated with the particles' surface during blending of the ingredients, at the beginning of the ice cream process.

In one version of the approach offered by the method of the invention, a lipophilic emulsifier (at a level of 0.15% w/w) is dispersed in a molten, commercial ice cream fat and the fat then sprayed as a fine aerosol or as a mist from a spinning disc or some other similar device, to impinge onto a liquid cryogen, or co-sprayed with the cryogen, or in some other way brought into close contact with a cryogen to obtain the highest rate of cooling. The resulting fine powder consists of numerous spherical fat particles, each of which consists of a mass of very fine fat crystals with entrapped pockets of oil. These particles can be added directly to the aqueous phase of ice cream mixes to produce a fine fat dispersion of what is, in effect, an emulsion. This emulsion can be wetted by the aqueous phase because of the presence of emulsifier on the surface of each particle. Individual fat particles act as globules of fat that are able to stabilise air bubbles by attaching to their surface when, as part of the normal ice cream making process, air is incorporated into the aqueous phase during freezing. Emulsions formed in this way freeze to form ice cream with the same appearance and similar mouth-feel as commercial ice creams.

In another version of this technology, a lipophilic emulsifier is dissolved in the fat phase, as described above, but the aqueous phase to which the fat is added also contains a very surface active, water soluble emulsifier, such as 0.1% polysorbate 60. Whereas the lipophilic emulsifier and the polysorbate facilitate wetting of the fat particles' surface by the aqueous phase during blending and ensures that emulsifier is already present at the surface of the fat particles when the aqueous phase is added, the water soluble emulsifier lowers the surface tension of the fat particles to very low levels and promotes the separation (and wetting) of fat crystals from fat particles. In this way, both fat crystals and fat particles are able to take part in air bubble stabilisation when the aeration process begins, to produce a stable foam and a distinctive mouth-feel in the frozen ice cream. In some cases, only the highly surface active emulsifier in the aqueous phase is needed to obtain wetting of the fat powder when it is added to the aqueous phase.

Alternatively, an ice cream may be made by first preparing a fat powder by cryogenic spray crystallisation (as described above) of the chosen fat phase, but without a lipophilic emulsifier added to it, and instead using a water soluble monoglyceride dissolved in the aqueous phase with the other water soluble ingredients.

A positive advantage of this general approach to ice cream making is that the disperse fat phase, like many other ingredients, can be prepared and conveniently stored as a stable powder until it is needed and then added either a) to the prepared aqueous phase or b) to the other, dry water soluble ingredients of the ice cream mix followed by the addition of water and high speed mixing. This instant formation of an oil-in-water ice cream mix ready for immediate aeration and freezing provides a simple, rapid and continuous process for ice cream production that avoids many of the problems, delays and the inherent costs encountered in conventional, batch processes.

In the method of the invention it has been found that the size of the fat particles can be controlled by a number of means including a) the design, specification and operating conditions of the aerosol nozzle or of the spinning disc or of the device used to produce the fine dispersion of fat to be frozen by the cryogen, b) the magnitude of the shear applied in dispersing the fat powder in the aqueous phase of the ice cream mix and c) the solid fat content of the fat at the temperature of blending.

The fat to be used for processing by the method of the invention should be preferably be one whose solid fat content at the temperature of storage, say 5°C, is high enough to maintain its state as a non-compactable, free-flowing powder. At the same time, at the temperature of air incorporation and freezing, some oil should still be present to facilitate attachment of fat globules (particles) to the surface of bubbles in sufficient numbers to give an optimal level of air incorporation and an overrun greater than 20%. Hardened palm kernel oil has been found to satisfy these conditions.

Whichever of the variables given above to control fat particle size, it has been found advantageous to freeze an ice cream mix in which the disperse fat phase is advantageously no more than 25μm in diameter and preferably no more than 5μm in diameter. Particles larger than 25μm in diameter are known to produce poor mouth-feel, low overrun and loss of quality.

CLAIMS

1. A method for pre-preparing the fat phase or globular fat of an ice cream mix in the form of a powder.

2. A method for producing a stable powder of fat particles or globules by the use of spray freezing in conjunction with a cryogen or some other cooling regime that immediately crystallises the globular fat. This fat forms the disperse fat phase of an ice cream mix that can be prepared for aeration and freezing simply by addition of the aqueous phase but without the necessity of employing the homogenisation and "conditioning" or "ageing" steps of conventional processes.

3. A method that uses the incorporation of lipophilic emulsifier into fat powders so that the powders are easily wetted by the addition of an ice cream aqueous phase, and subsequently undergo emulsion destabilisation and facilitate the stabilisation of bubbles during aeration.

PCT Application
GB0303503